

Subtracting the combinatorial background

- Using $\mu^+\mu^+$ and $\mu^-\mu^-$ pairs or a recombination method
Hypothesizes, advantages, disadvantages...
- What is used by:
 - other experiments
 - within PHENIX
- Simulation and data (first attempt...)
- Outlook

Using $\mu^+\mu^+$ and $\mu^-\mu^-$ pairs

- **Hypothesizes:**

H1: Muons from a pair are not physically correlated

H2: No correlation between meson + and – multiplicities

H3: Multiplicities follow a Poisson distribution

- **Experimental constraint:**

$$\text{Acc}^{\mu^+\mu^-}(M_0) = \text{Acc}^{\mu^+\mu^+}(M_0) = \text{Acc}^{\mu^-\mu^-}(M_0) \rightarrow N^{\mu^+\mu^+} / N^{\mu^-\mu^-}$$

$$\begin{aligned} N^{\mu^+\mu^-}(\text{Bgr}) &= 2 (N^{\mu^+\mu^+} N^{\mu^-\mu^-})^{1/2} \approx N^{\mu^+\mu^+} + N^{\mu^-\mu^-} \\ N^{\mu^+\mu^-}(\text{Sgl}) &= N^{\mu^+\mu^-} - N^{\mu^+\mu^-}(\text{Bgr}) \end{aligned} \quad \left. \right\} \text{for A-A}$$

Using $\mu^+\mu^+$ and $\mu^-\mu^-$ pairs in p-p, p-A...

Small multiplicities → H2 (no correlation between mesons + and mesons -) not right:

$$N_{\mu^+\mu^-}(\text{Bgr}) = 2 R (N_{\mu^+\mu^+} N_{\mu^-\mu^-})^{1/2}, \quad R > 1$$

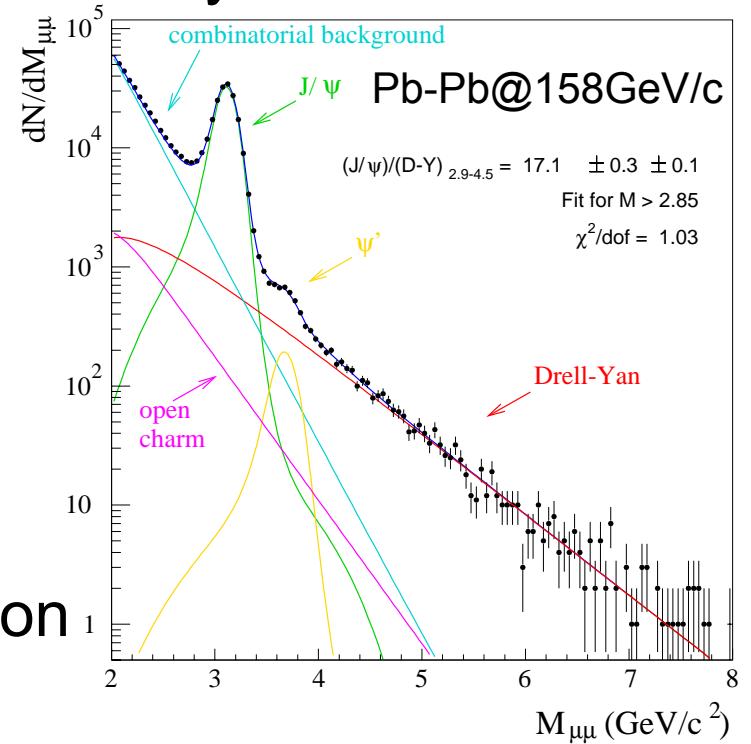
R estimated using MC simulation

Recombination method

- **Hypothesis:** muon cinematic distributions from pairs identical with distributions if measure muons individually
- **Condition:** combination between muons from same Δz_{vertex} and Δb class of events
- **Advantages:**
 - high statistics
 - do not need $\text{Acc}^{\mu+} = \text{Acc}^{\mu-}$
- **Difficulties:**
 - Bias introduced by cuts (deep...)
 - Uncertainty calculation

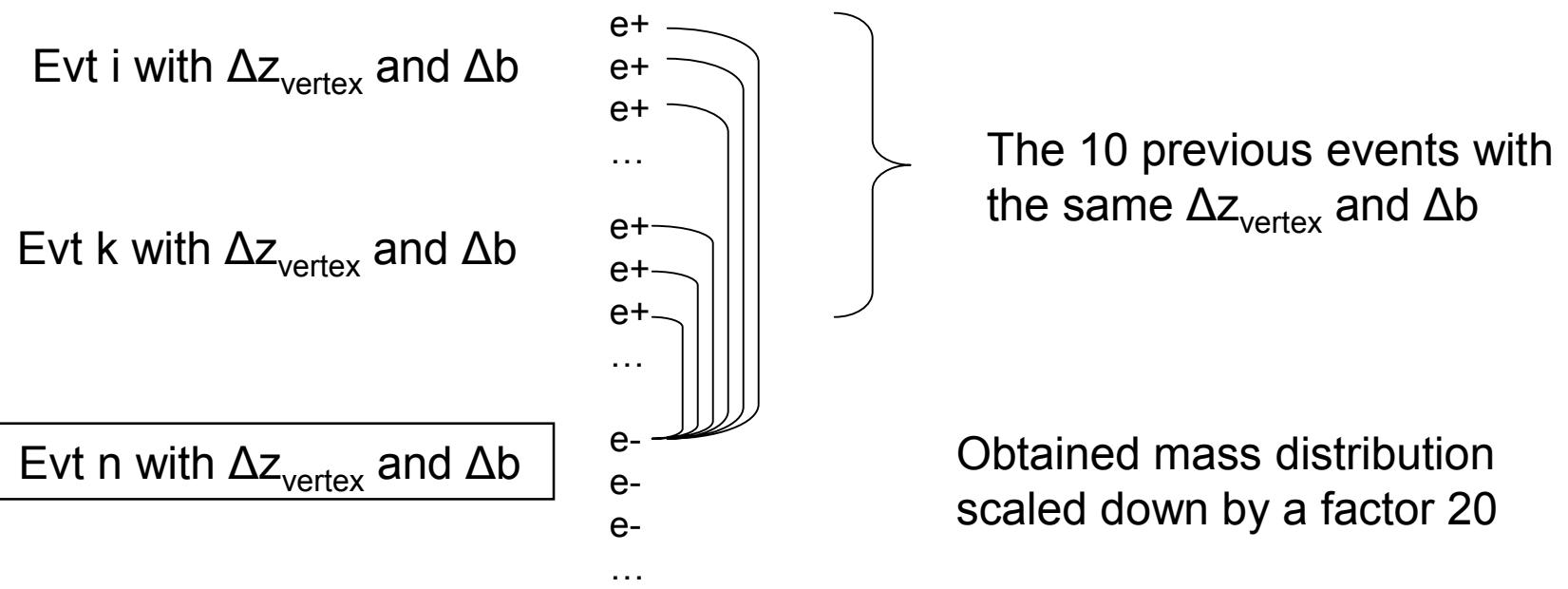
Experiments measuring μ's or e's

- HELIOS/3 (CERN/SPS) – μ's: recombination method and $R \equiv N^{\mu+\mu-}(Bgd)/2(N^{\mu+\mu+}N^{\mu-\mu-})^{1/2}$ determined by VENUS
- NA38/NA50 (CERN/SPS) – μ's:
 - Φ , ρ , ω , J/ψ , ψ' studies:
 - $2(N^{\mu+\mu+}N^{\mu-\mu-})^{1/2}$
 - Intermediate masses: recombination method and R from VENUS
- CERES/NA45 (CERN/SPS) – e's: $N^{e+e+} + N^{e-e-}$
- E866 (Fermilab) – μ's: recombination method



Experiments measuring μ 's or e's in HIC

- PHENIX – Central arms - e's: 2 recombination methods
 - Yasuyuki Akiba: 40 Δz_{vertex} bins and 6 centrality bins



- Felix Matathias: for each event, keep only one e^+ or e^- and put it in the event “pool” ($\Delta z_{\text{vertex}}, \Delta b$). When reach a predefined depth, start combining.

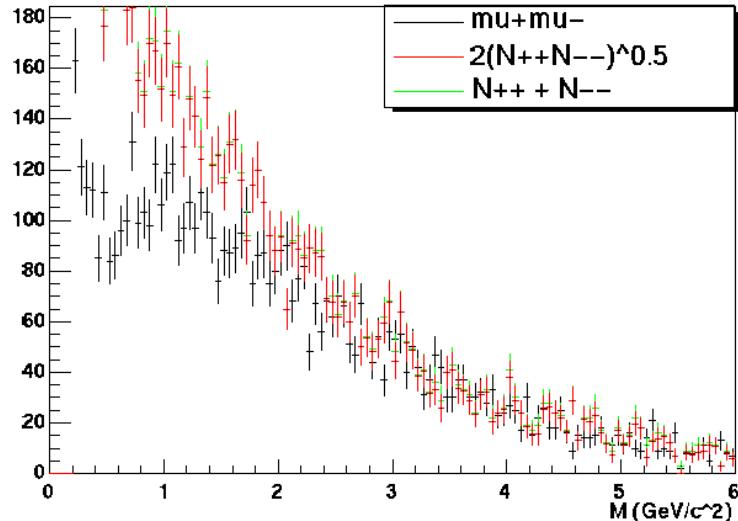
Au-Au: mass spectra

Real Data (before Sept 17th)

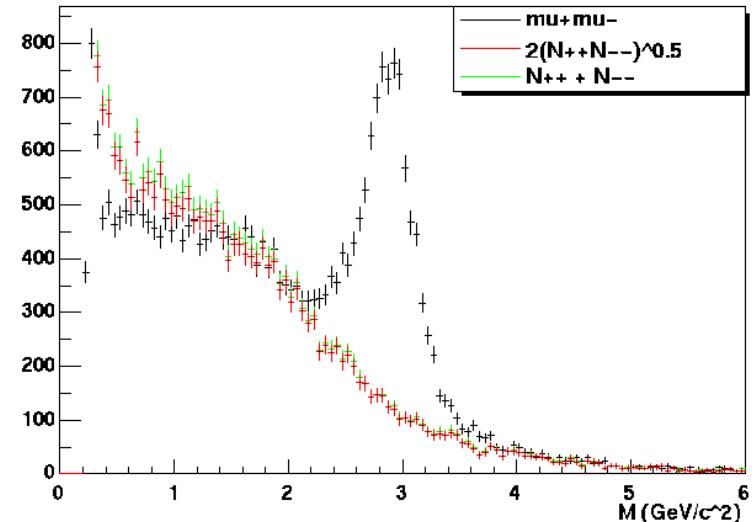
No ghost

Simulation Central + J/ ψ (MDC)

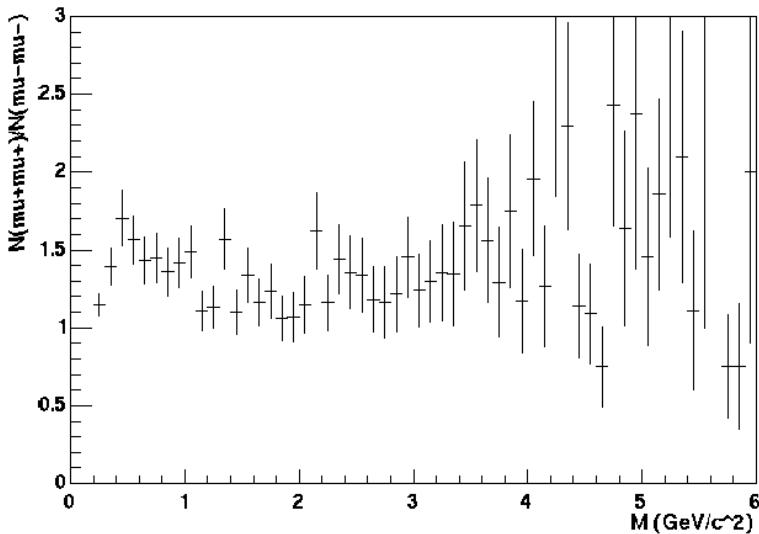
hMassPM



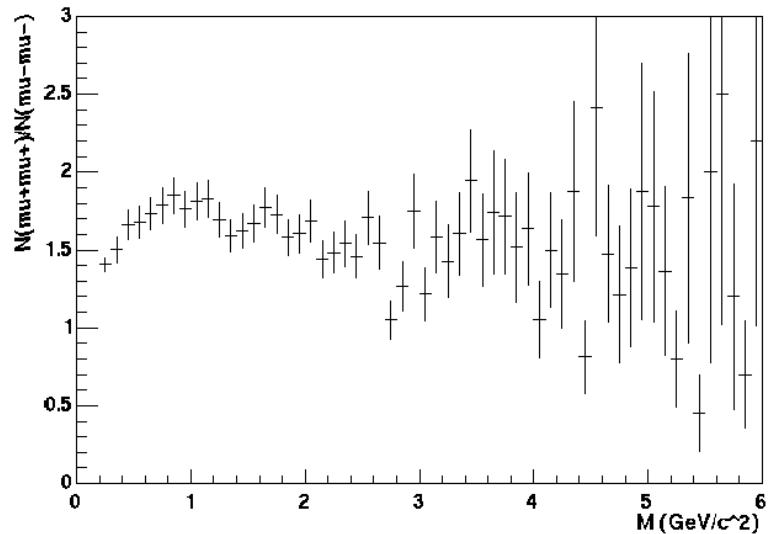
Mass mu+mu- pairs



mu+mu+/mu-mu- Ratio Versus Mass

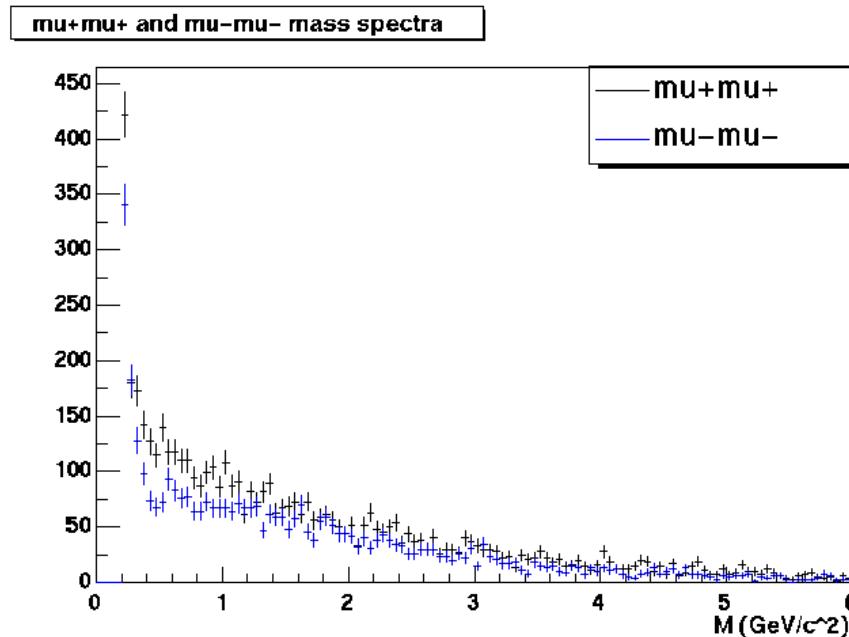


Simul : mu+mu+/mu-mu- Ratio Versus Mass

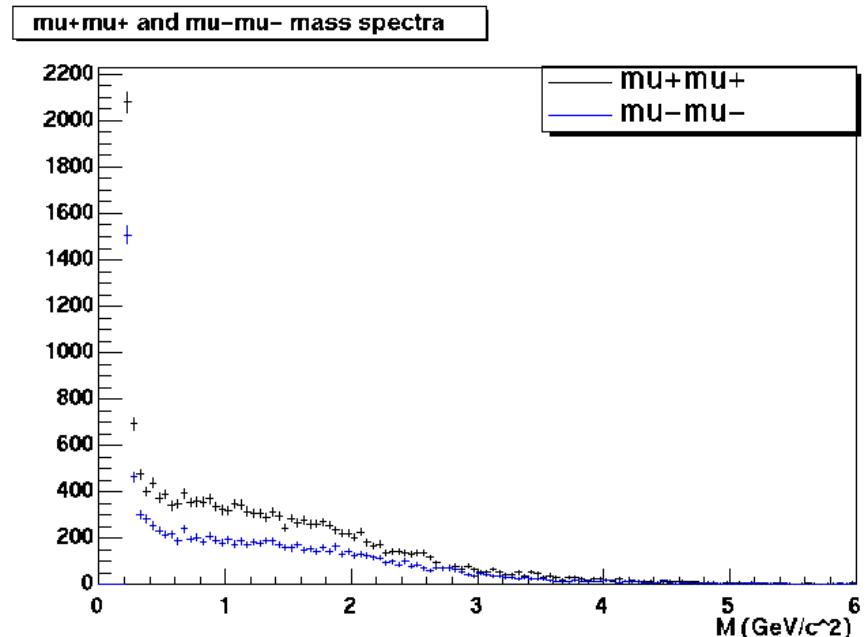


Au-Au: mass spectra

Real Data (before Sept 17th)



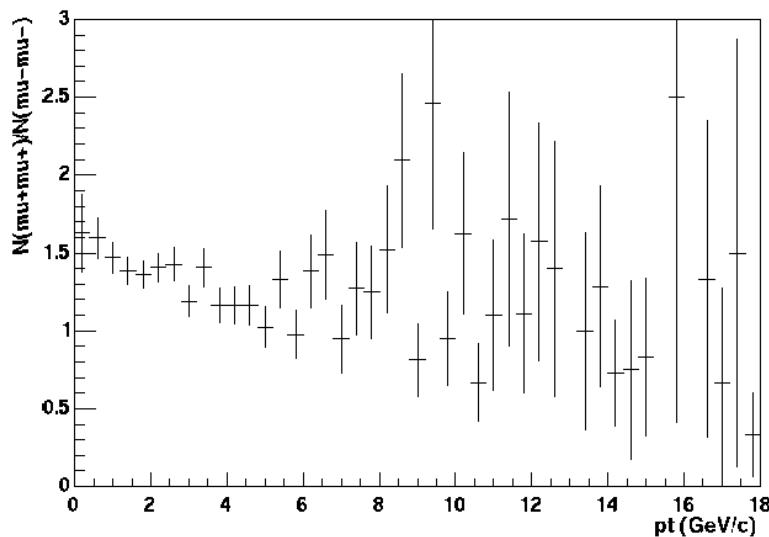
Simulation Central + J/ψ (MDC)



Au-Au: p_T and y spectra

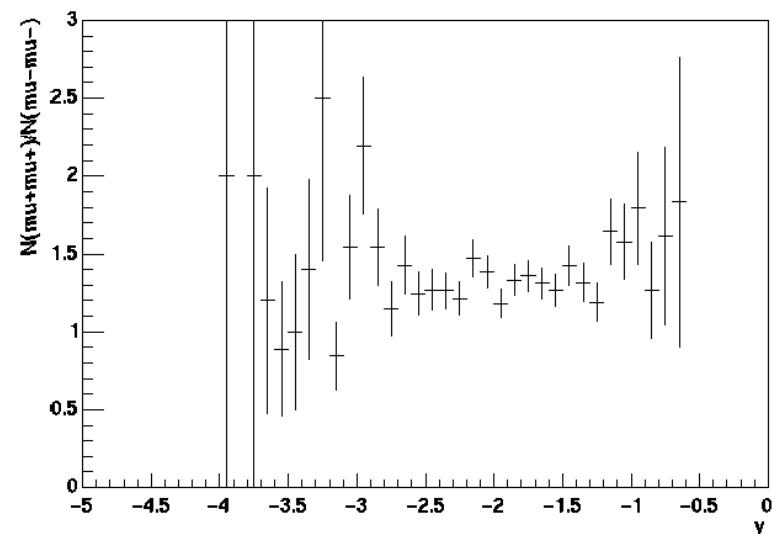
p_T

mu+mu+/mu-mu- Ratio Versus p_T

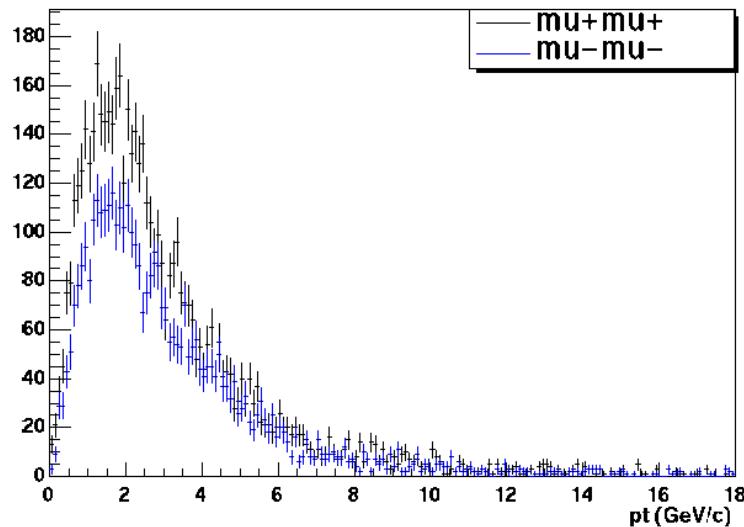


y

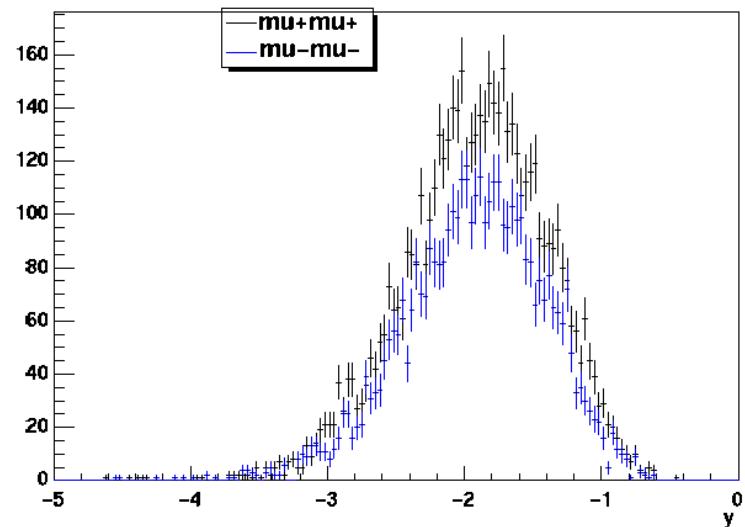
mu+mu+/mu-mu- Ratio Versus y



mu+mu+ and mu-mu- p_T spectra



mu+mu+ and mu-mu- y spectra



Outlook

- Data with the correct value of B
- Simulations with the last changes (shielding, reconstruction chain, new code...)
- Effect of the dead channels and the inefficiencies
- Effect of the polarity of the magnetic field
- More statistics for data and data w/ shielding

References

Recombination method and R calculation in NA38/NA50:

- “Etude de la production du J/ ψ dans les réactions p-Cu, p-U, O-U et S-U à 200 GeV par nucléon” PhD thesis S. Papillon, Paris-7 university (March 1991), IPNO-T.91.03
- “Estimation of the combinatorial background in dimuon spectra using recombination of muons, and associated error” S. Constantinescu, S. Dita, D. Jouan (1996), IPNO-DRE-96-01
- “Intermediate mass dimuons in ultrarelativistic proton-nucleus and nucleus-nucleus collisions at the CERN-SPS” PhD thesis Cristina Soave, Tesi di Dottorato di Ricerca, Università Degli Studi Di Torino, April 1998.
<http://na50.web.cern.ch/NA50/theses.html>

Recombination method and R calculation in HELIOS 3:

- HELIOS 3 collaboration: Eur. Phys. J.C:13(2000) n03 p433

Recombination methods in PHENIX central arms – e’s:

- Y. Akiba: <https://www.phenix.bnl.gov:8080/phenix/WWW/p/draft/akiba/01.01/> AN_PART2.pdf
- F. Matathias: <http://www.phenix.bnl.gov/phenix/WWW/p/lists/phenix-heavy-l/recent/msg00240.html>

Limit of the methods estimating the combinatorial background:

- M. Gaździcki and M. I. Gorenstein hep-ph/0003319

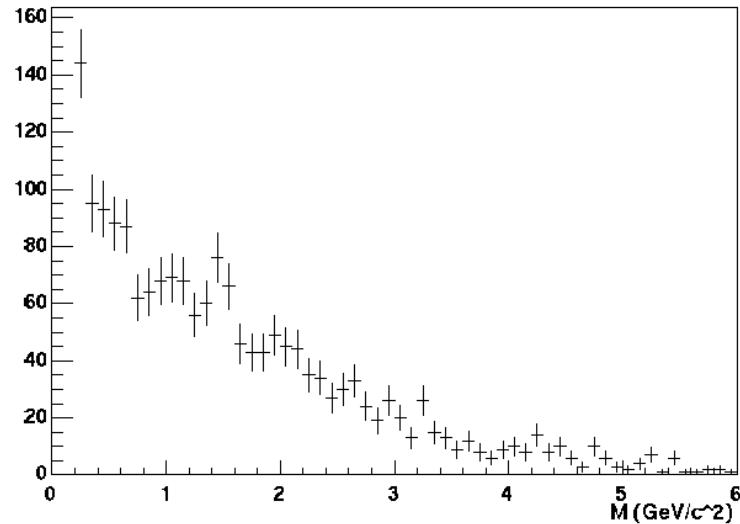
Combinatorial background in ALICE:

- P. Crochet and P. Braun-Munzinger nucl-ex/0106008

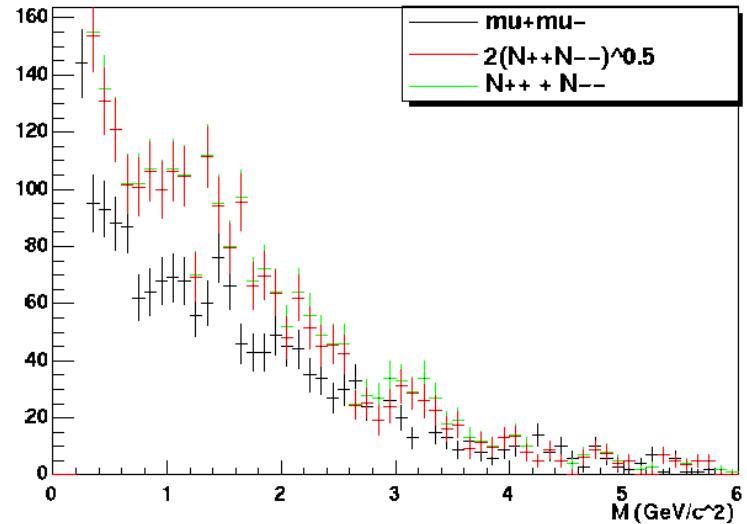
p-p: mass spectra

Hiroki's DST's - No ghost

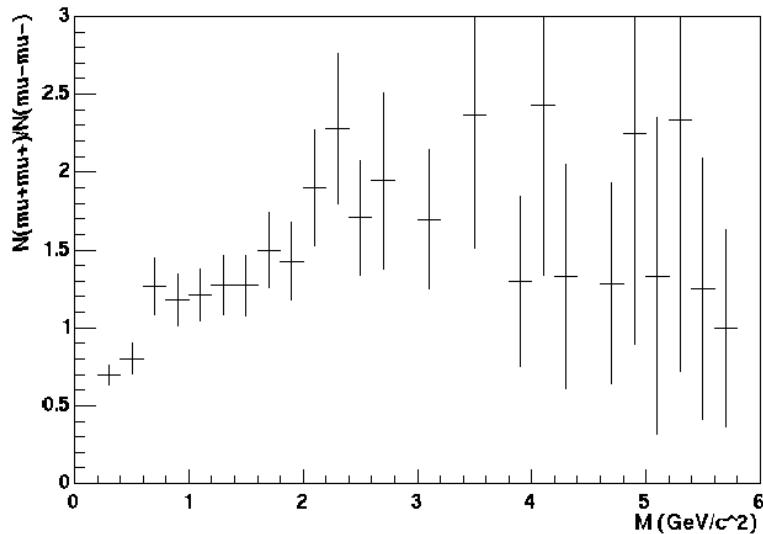
mu+mu- Mass



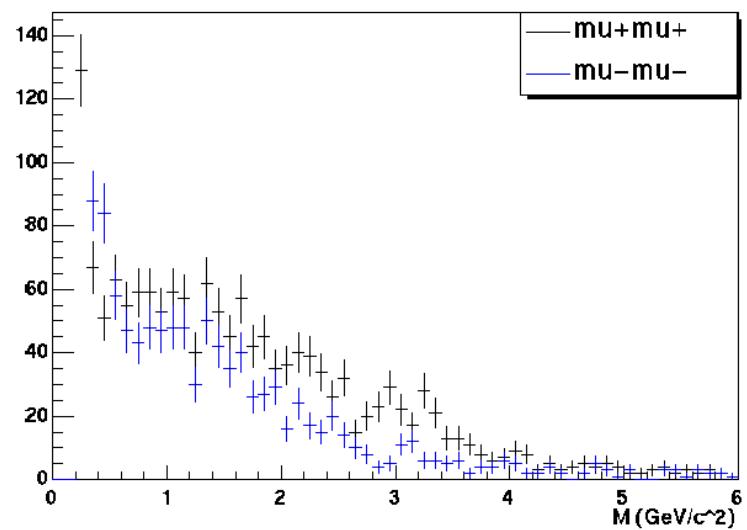
hMassPM



mu+mu+/mu-mu- Ratio Versus Mass

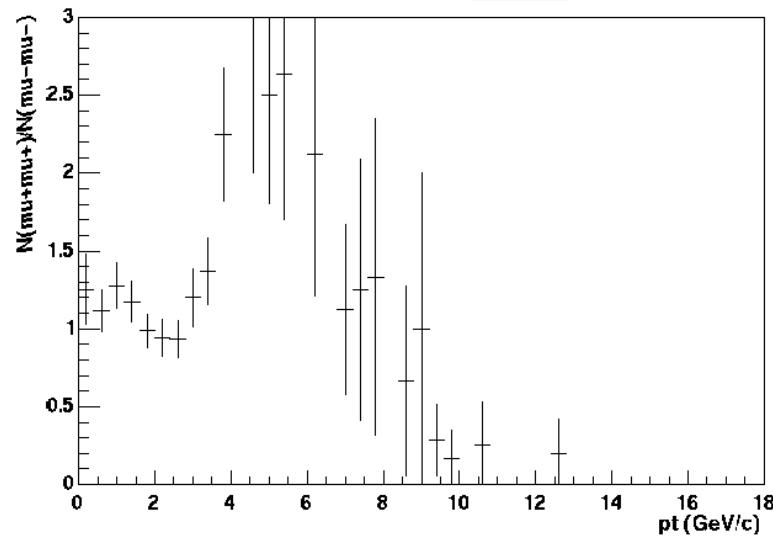


mu+mu+ and mu-mu- mass spectra

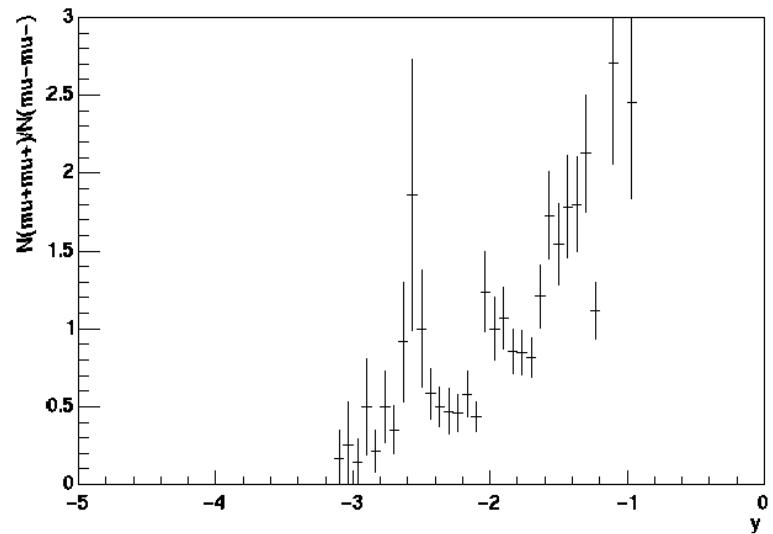


p-p: p_T and y spectra

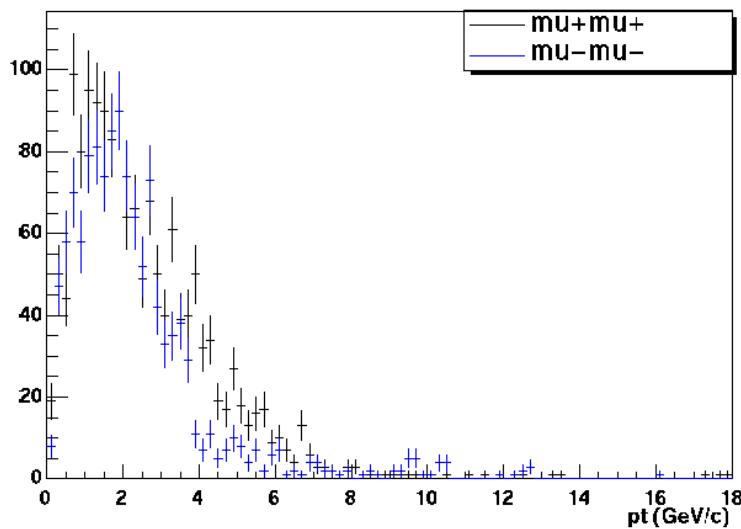
$\mu^+\mu^+/\mu^-\mu^-$ Ratio Versus P_T



$\mu^+\mu^+/\mu^-\mu^-$ Ratio Versus y



$\mu^+\mu^+$ and $\mu^-\mu^-$ p_T spectra



$\mu^+\mu^+$ and $\mu^-\mu^-$ y spectra

